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DOD SPACE SYSTEMS - REDUCING THE COST

by

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A RESEARCH REPORT SUBMITTED TO THE FACULTY

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April 1993

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INTRODUCTION

"The military DoD space program and the commercial space program are inextricably entwined. We all must become more competitive because our commercial program is just as vital to the strategic importance of this nation as is our military." (Horner:speech) General Charles Horner, Commander of U.S. Space Command, thus set the challenge for military space programs as we move into the 1990's and beyond. A new era is dawning as space becomes not just the arena of the superpowers but of other countries, and commercial industries, as well. With the end of the cold war threat, and declining military budgets, it is imperative that the DoD examine alternatives to "going it alone" in the space arena. Opportunities exist for the DoD to utilize the assets of other nations, utilize commercial space assets, and even charge civil users for the space products that the DoD currently provides. The growth in space can be seen around the globe. Japan has developed a launch capability, along with communications and remote sensing satellites. France competes with the U.S. for satellite launches using the Ariane booster, and operates the SPOT remote sensing satellite that was used by the American military in the Persian Gulf War. Canada has firm plans to orbit a radar imaging satellite and sell the products to anyone who needs them. Commercial firms are active in communications, remote sensing, materials processing and launch capability.

Despite these opportunities, change will be difficult due to the long standing tradition and policy to separate the military

use of space from the civil and commercial aspects of space operations. This is based on historical precedent going back to the Eisenhower Administration, in which President Eisenhower explicitly demanded that the two efforts be separate; the U.S. focus, at least publicly, would be on the "peaceful" uses of space. However, this is not an insurmountable obstacle. Space has been utilized by the military since the space age began, and most people accept that high technology space systems provide capabilities critical to our national well being and efficient operation of our troops in the field.

The challenge, then, is to move beyond the old models and examine alternative opportunities to accomplish the DoD space mission at reduced cost. Utilization of dual use technologies (commercial and other country capabilities) can reduce the cost of developing and operating DoD space systems and should be pursued in an era of declining budgets. Doing so will also make the most efficient use of our "space" industrial base, and maintain the U.S. as the premier space power in the decade ahead.

CHAPTER I HISTORICAL POLICIES AND THE CURRENT ENVIRONMENT

Historical Policies

The current separation between military and civil/commercial space efforts can be traced back to the dawn of the space age in the early to mid-1950s. This was a time of intense competition with the Soviets, as the U.S. and U.S.S.R. each sought to maintain technological superiority and a credible nuclear threat. However, the U.S. Air Force at the time was not focused on the development of the intercontinental ballistic missile, which was the forerunner of boosters necessary to achieve access to space. "The widespread conviction of most senior US Air Force officers that for the foreseeable future their country's nuclear arsenal could be satisfactorily deployed and if necessary delivered by manned bombers played a key role in delaying the start of a serious American ICBM project. Actual development was initiated by the Department of defense early in 1954, some four or five years later than the Soviet equivalent." (Sput:17) As the ICBM program proceeded, the impetus began to focus on placing an artificial satellite in orbit to support the International Geophysical Year (IGY), "a period of international cooperation in the geophysical sciences in 1957 and 1958." (Sput,17) "In 1955 the United States announced that it would attempt to launch satellites for the IGY, and a similar commitment was made a year later by the Soviet Union." (Sput:17) At this point, the US had three options to launch the proposed satellite: "the USAF's Atlas, the Army Ballistic Missile Agency's Jupiter-C, or an

entirely new launch vehicle based on the Viking sounding rocket technology. It was at this point that President Eisenhower's philosophy of wanting to present an image to the world of the United States fostering the peaceful uses of space was born." (Sch:45) The administration chose the Viking option "as the most appropriate for the civilian character of the IGY's scientific efforts." (Sch:45) Ironically, the Viking booster, renamed project Vanguard, experienced a series of problems, and it was the Army's Jupiter-C that launched the first US satellite in January 1958. This did not deter President Eisenhower's belief that the US space program should be controlled by a civil agency, however. As the Soviets expanded their space lead, and Congressional debate raged, the preferences of the Eisenhower administration became firm. "They were in favor of a civilian agency to handle all aspects of research and development with scientists playing an important role in guiding the space effort." (Sch:48) The Administration's efforts culminated with a legislative proposal sent to Congress on 14 April 1958 to establish the National Aeronautics and Space Administration. However, "reflecting the President's views on the civilian nature of future space endeavors, the legislative proposal left the NASA-DOD relationship vague with no formal coordination dictated. In fact, the administration never envisioned a joint civil-military space program." (Sch:51) Congress recognized, however, that the military had a role to play in space, and the language that was signed into law by President Eisenhower on 29 July 1958 stated:

The Congress declares that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities. The Congress further declares that such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except that activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States shall be the responsibility of, and shall be directed by, the Department of Defense...

The die was cast, with NASA as the lead agency, but to be supplemented by DoD in areas of national defense. Dollars tell the story well. Figure 1 (Exp:18) shows that military expenditures for space exceeded NASA's (and the civil agencies that preceded NASA) prior to 1959. However, after 1959, NASA's budget far outstripped the military space budget, and this continued until the early 1980s.

In addition to the civil-military relationship established in the late 1950s, the interface with commercial ventures seeking to exploit space was defined in the early 1960s. This issue initially surfaced in communications satellite research. Initially, the Eisenhower administration sought to let market forces work to determine who would be able to exploit this new communications capability to make a profit. However, the Kennedy administration was concerned that a monopoly would be created, since AT&T alone seemed to have sufficient resources to invest in this new technology. Kennedy reversed the policy and "authorized NASA to conduct a vigorous program of research in the communications satellite area and took the initiatives to create

a totally new commercial organization, Comsat, as the means for bringing communications satellites into being." (Exp:55) The precedent set here was for government and industry to join together in developing space technology applications, "with the appropriate division of roles to be determined on an ad hoc basis for each area of applications; the goal, however, is eventual private sector operation of space application systems. In each area in which a space application has reached or approached maturity, such as point-to-point communications and some applications of remote sensing, business structures have emerged which operate as commercial enterprises related to that application." (Exp:55) Therefore, for both the military-civil and military-commercial relationships, the mode of interaction was defined by the early 1960's and has remained essentially unchanged to the present.

Current Environment

There are now substantial differences in the space operating environment as compared to the early 1960s. The first major difference is the existence of a vibrant commercial, semi-commercial and other government space program. General Horner stated that "Space has come of age. You see in commercial satellites the growth, and that just continues. Certainly in our civil sector, we have a very robust program going." (Horner) This can clearly be seen in the number of commercial communications satellites operating: from four in the mid-1960s to over forty today. (Horner) Remote sensing from space has also gone commercial to an extent. A commercial business, Eosat, now

operates the existing Landsat earth resources satellite, and the French have introduced a commercial capability (with some government support) with their Spot remote sensing satellite. Orbital Sciences Corporation of Fairfax VA is now moving forward with plans to build and operate an ocean study satellite called SeaStar as a commercial venture. (SN:10-16Aug92:6) Canada is also proceeding with plans to launch a radar imaging satellite in early 1995. "Canadian officials want to encourage commercial applications abroad to cover some of the spacecraft's operating costs." (SN Oct5-11,92:16) These expanded capabilities, apart from the DoD, provide opportunities to utilize these assets to support future DoD requirements in a synergistic way.

The second major change is the heavy reliance by the US military on space assets to conduct its mission. General Robert Herres, former Deputy Chairman of the Joint Chiefs of Staff, stated that "the use of space is mandatory for the success of most of our military operations today." (SP,92) This was clearly seen in operation Desert Storm. The dramatic success of the Allied forces was in great measure due to the support they received from space assets. Navigation, weather information, communications, imagery - all were provided by space systems and allowed our forces to operate in the featureless terrain of the desert with great success. In fact, the key role played by space systems led many key Air Force leaders to call this the first "space war" and the Congressional Research Service stated that "space assets have proved invaluable" in the war. (CRS:1) This reliance on space assets further increases the imperative to

utilize all space assets to their greatest extent, including commercial and other nation assets.

The final major area of change is in the budget for DoD in general, and space programs in particular. As with all other areas in the DoD, we are going to be required to do more with less in the years ahead. As General Horner said, "And even if we didn't want to change, we are going to have to. The reason, as you know, is that the money is not going to be there for the military." (Horner) Contrast this with the curve in Figure 1, which showed the steadily increasing funding for the DoD space effort, especially in the 1980s. According to former Secretary of the Air Force Don Rice, space systems "will receive a steady 18 percent of the spending" in the Air Force budget. (SN:9/21:1) Unfortunately, Rice also states that the Air Force budget will decline to the \$50-55 billion dollar range, versus the \$90 billion plus range we saw at the height of the Reagan buildup. (SN,9/21:1) For space programs, this translates to a decrease from approximately \$16 billion to \$10 billion annually. Even classified, high priority programs are feeling the pinch. The FY93 "defense appropriations bill sliced \$1.6 billion from the requested foreign intelligence programs, and most of that money will come from the United States' spy satellite programs... As a result, entire spy satellite systems are being cancelled.(3:2) Clearly, we must be smarter in how we spend our money to meet the warfighter's requirements, especially since his reliance on space systems will continue to increase while our budget declines.

The challenge then is clear. We in the DoD must take advantage of all available space systems in order to support the warfighter in a declining budget environment. We must be willing to accept new ways of providing that support, making maximum use of our commercial assets, our contractor capabilities, and resources of other countries. We must take a holistic approach to military space in the 1990s.

CHAPTER 2 - SPACE SYSTEM REQUIREMENTS

The requirements levied on military space systems are certainly more stringent in many areas when compared to civil/commercial systems. The question that must be addressed is whether there is overlap among these requirements that would allow civil/commercial/other nation systems to meet our particular DoD needs and provide adequate support to the warfighter. This chapter will examine those requirements in each of the four mission areas (communications, imagery, navigation and weather) and assess the capability of non-DoD systems to meet our needs.

Communications

Military satellite communications (MILSATCOM) is generally required to operate in high threat scenarios (cold war, nuclear exchange, etc). This leads to requirements for jam resistance to prohibit interference with signals and survivability enhancements to ensure the system survives potential attack. However, these capabilities do not come without cost. "Measures to provide jam resistance, such as spread spectrum techniques, reduce capacity because they are less efficient in spectral utilization than conventional signaling methods. Survivability enhancement increases costs by requiring special design approaches and extra testing of components and subsystems." (Rand p9) Meeting these requirements results in "both increased cost and reduced capacity, adding to the need to prioritize users." (Rand p9) This reduced capacity was graphically demonstrated in the Gulf

War, when the MILSATCOM system was simply overwhelmed with the requirements levied on it. General Merrill McPeak, Air Force Chief of Staff, stated that "we way underestimated the amount of communications support we would need for Desert Storm. We weren't even in the same ballpark, off by a factor of four or five in our estimates." (SN 15 Feb 93) This led to the extensive utilization of commercial capabilities in that conflict. Lt Gen James S. Cassity, Director of C3 systems for the Joint Staff, stated that commercial communications resources were employed for "the passing of command and control information." (Rand p8) "Overall, commercial communications satellites provided about half of the long-haul communications capacity used by the U.S. military in the early months of the deployment." (Rand p8) Clearly, commercial communications satellites have the capability to meet a significant portion of the military requirement as demonstrated in Desert Storm. In addition, commercial communications satellites do offer some jam resistance and survivability features. Standard design practices for operating in the space environment provide protection against radiation. Also, "some jam resistance can be obtained while using wideband commercial communications satellites." (Rand,9) Certainly, there may be certain stressed military environments that overwhelm the commercial system, but there are a significant number of scenarios where commercial communications capabilities will meet the military requirement.

Imagery

Military imagery requirements "focus on obtaining detailed information of a specific nature." (Space course, 19) Space based sensors can be used to observe deployments of troops and equipment, perform bomb damage assessment, develop digital terrain modeling, etc. What you can see is determined by the resolution of the space based sensor, i.e. what is the size of the object that it can detect on the ground. "As a rough guide, resolution of no better than twenty meters is useful primarily for natural resources analysis and other economic purposes; resolution of one to ten meters is useful for military reconnaissance; and resolution of better than one meter is needed for precise description and technical analysis of military hardware." (space book, 35) Table 1 indicates the necessary resolution to detect and identify certain targets. Note that general identification of bridges, airfield facilities, surface ships, minefields, landing beaches, roads, railroads and surfaced submarines can all be accomplished with resolutions of about five meters, and troop units can be detected at this level of resolution. This is certainly militarily useful information. In addition, resolutions in the ten meter range can be "particularly useful for the update of military maps and ready location of new roads, bridges, and other physical changes." (Science and Tech, p37) In fact, the Defense Mapping Agency used multispectral imagery from the Landsat satellite in Desert Shield/Storm to quickly produce updated maps of the Gulf region. It is clear that systems with resolutions of five meters and up will provide

significant military information and meet many military requirements. While commercial systems perform at only about ten meter resolution today, five meter resolution is coming. "SPOT Image and the French government are preparing to invest more than \$1 billion to develop, build and launch a new, improved line of SPOT Earth observation satellites as early as 1999." (SN, 1/25,18) "SPOT Image officials hope to equip the SPOT 5 satellite with sensors capable of spotting objects as small as 5 meters across." Here again, there is a merging of military and civil requirements which leads to the possibility of commercial assets meeting some component of the military need.

Navigation

Military requirements for worldwide navigation accuracies are extremely demanding. The military system requirement on the Navstar Global Positioning System (GPS) is to provide 16 meter accuracy 24 hours a day worldwide. This requirement supports a myriad of military operations, including precision bomb drop, accurate ingress and egress through enemy territory, precision rendezvous, etc. The civil community, however, is also clamoring for the 16 meter accuracy to support a multitude of applications: everything from oceanic navigation, en route and precision approach for aircraft, and oil well drilling. GPS is a unique case in that an all military system, developed with DoD funds and intended for military use, will have more civil users than military users when the system is declared fully operational. From an accuracy requirement point of view, then, the civil and

military needs are essentially the same, and in some cases (precision approach for civil aircraft, for example) the civil requirement is actually more stringent than the military requirement.

Weather

Knowledge of meteorological conditions are critical for planning military operations. Cloud cover, thunderstorms, dust storms, etc can all effect military operations both positively and negatively. The military commander must know the weather in his area of operations and have a reasonable forecast of what the weather will be in the future. The Defense Meteorological Satellite Program (DMSP) provides this weather information to the military. This type of information was key to military operations in Desert Storm. DMSP "images of cloud cover and other weather conditions greatly influenced the planning and flying of sorties, plus the selection of weapons to be taken along." (Space book,4) Lt Gen Thomas Moorman, Vice Commander of Air Force Space Command, stated that "our wings knew which targets were clear and which were covered, and they were able to optimize their weapons loading. Very few sorties resulted in bombs not dropped." (Space book,4) Civil authorities also have requirements for weather information obtained from space assets, as evidenced by the the pictures seen on the local news each evening. There are subtle differences in requirements, however. The U.S. civil system, operated by the National Oceanic and Atmospheric Administration (NOAA), has a primary requirement to

provide "precision vertical temperature and water vapor sounding for incorporation in the world's twice daily synoptic forecast models." (McElroy,317) The DoD system, is more focused on pictorial (spatial) cloud cover information to aid the military commander in operational planning. Therefore, the overall requirement to obtain meteorological information is similar for DoD and civil agencies, but the type of data that is obtained is different and does not neatly overlap.

Summary

In examining the four primary space mission areas, it is clear that requirements overlap (and capabilities convergence) between the DoD and commercial/civil areas exist to one degree or another in each of the areas. This is fundamentally different from many other DoD mission areas such as fighter aircraft or bombers, where no comparable commercial/civil requirement or capability exists. This requirements and capabilities overlap provides the DoD with the opportunity to seek areas of convergence with civil/commercial systems and synergistically integrate these systems into an overall DoD space capability that will provide increased capability at lower DoD cost.

CHAPTER 3 - CIVIL/COMMERCIAL SYSTEM AVAILABILITY

The previous chapter showed that there are significant overlaps in military and civil/commercial requirements. However, this does not necessarily mean that civil/commercial capability will exist to support military operations simply because a requirement exists in the civil/commercial market. A case in point is the Navstar GPS system. There currently exist a host of civil and commercial requirements for world wide, highly accurate navigation information. However, the only system that truly provides this capability is GPS, a DoD system. While there are many reasons for this (DoD essentially created the requirement by fielding the system), it points out that we must examine the current and future capabilities in the civil/commercial world to confirm the hypothesis that systems will be available for military utilization.

Market Analysis

An overall market survey confirms that the civil/commercial sector of the space industry is healthy and providing significant capabilities. In the U.S. alone, spending on military and civil space programs topped \$35 billion in 1992, which is equivalent to 0.6 percent of the gross domestic product. Forty percent of that spending was for civil space programs. (SN1/25) Also, "despite the recession that has flattened the aerospace industry in most of the industrialized world, space budgets grew at more than a commensurate pace, even after economic activity had begun to slow

down." (SN 1/25) American firms continue to lead the way in the civil/commercial space market. Hughes Space and Communications and GE Astro have captured over 56 percent of the commercial/civil market, with Space Systems/Loral of Palo Alto capturing an additional ten percent. The first non-U.S. company on this list is Matra of France, with a 9.8 percent market share. (SN 1/25) Clearly, the overall civil/commercial is stable/growing, and the U.S. has captured the lions share of that market.

The size and availability of this market can be clearly seen in three of the four mission areas (communications, imagery, and weather) with navigation being somewhat less represented. In communications, there are currently over forty commercial satellites on orbit. For the period 1990-1996, the "total market for these satellites ...is 125 spacecraft launched or firmly ordered, with a market value of \$10.4 billion in 1992 economic conditions." (SN1/25) Future commercial communications satellites will offer a wide range of services, from video transmission to worldwide cellular telephone service to mobile terminals. In the commercial arena, "the costs of the service and terminals are decreasing, the terminals are growing smaller and more convenient, and the services are increasing in availability." (Rand/Army 36)

Imagery satellites also offer a stable and growing market that the military can potentially use. "There are four earth resources satellites in orbit that can be regarded as candidates for augmentation of DoD assets." (Rand/comm) These are two

Landsats operated by the U.S., a Japanese earth resources satellite called MOS-1, and the French SPOT Image satellite. As noted earlier, SPOT Image and France are already planning to invest more than \$1 billion to upgrade the SPOT satellite, and the system is moving to be on a completely commercial footing by the end of the century. "The long term goal is to pay all the system costs out of the commercial revenues from the system. We expect that by the end of the century SPOT Image will pay all the operating costs." (SN 1/25) Finally, there exist five weather satellites that the DoD could potentially access. These include three geosynchronous satellites operated by the U.S., Japan and Europe, and the two NOAA polar orbiting spacecraft.

Military Spending Impacts on Commercial Space Markets

While the civil/commercial space market is stable, one must question whether there is any relationship between military spending and the civil/commercial space programs, and if so, how will the steep decline in military spending affect this market. Regarding the dominant position of U.S. industry noted above, Rachel Villain of Euroconsult Paris states that "a lot of this (dominance) is due to the American military space spending, which has helped American industry in general." (SN 1/25) If this is true, how will the military downturn affect the commercial arena? A case study of GE Astro, the second ranking commercial space business provides some insight into this question.

GE Astro captured 13 percent of the commercial market in the 1970's, 17 percent in the 1980s and 27 percent so far for the

1990s. GE states that "much of the reason for our success in the commercial arena is a direct result of strong capabilities established through the years in our civil and military space businesses." (GE rpt) Given this situation, it would appear that a significant downturn in military spending would seriously cripple commercial capabilities. However, this is not the case. The commercial and civil market has matured to the point that there is no longer such a strong reliance on the military side of the business. GE again states that "since we have equal amounts of civil, military and commercial business today in annual sales, we would probably survive without our military business but would have to work harder to reduce costs to make up for the lost base." (GE rpt)

Another concern associated with the reduction in military spending is the loss of military technology dollars to support developments that commercial ventures could not afford. While there is some reason for concern here, the maturing communications and imaging markets in particular have sufficient impetus to develop their own needed technology. GE states that

In the past, there have been technology pushes in both the commercial and civil/military businesses, but with prime objectives being somewhat different. IN the commercial arena, technology pushes strived for cost and weight reductions as the main driver while in the civil/military arena, performance enhancements have been the key items. In these times of reduced Government budgets however, and with dual technology applications being stressed, the objectives are becoming more and more the same with emphasis on optimum balance between cost and performance factors.

Clearly then, in an era of reduced military budgets, the civil/commercial space programs have developed the maturity to survive and probably thrive. The dependence on military dollars is not the strong factor it was in the 1960s and 70s, and current worldwide military downsizing should have minimal impact on the availability of civil/commercial assets.

CHAPTER IV

DUAL USE ALTERNATIVES

As commercial capabilities and other nation space programs continue to expand, it is imperative that DoD seek ways to incorporate these systems into its stable of space assets. This chapter will examine several alternatives to our current way of doing business to reduce costs. I will focus on the key areas of navigation, weather support, communications and imagery. The alternatives examined include the following: developing "joint" space programs, either with other government agencies (FAA, NOAA, etc.) or countries (France, Canada); DoD continuing to operate systems while making their products available to civilians for a fee to offset costs; using a mixture of DoD and civilian systems to satisfy the mission; and finally, a complete reliance on non-DoD or commercial systems to support DoD requirements.

Partnerships with other government agencies

Probably one of the least controversial ways to address this issue is to seek partnerships with other government agencies who have similar requirements to the DoD with respect to space systems. Weather, navigation, and imagery are all mission areas where this potential exists. The possibility of merging weather systems has been discussed for several years. The National Oceanic and Atmospheric Administration (NOAA) has operated polar and geostationary weather satellites for civil use, while the DoD relies on the polar orbiting Defense Meteorological Satellite Program (DMSP) for its weather products. For the U.S. to operate

two separate and distinct polar orbiting weather platforms in this era of austerity begs the question: why don't we merge the two? Obviously, the key question to be addressed is how to meet the requirements of both organizations using the same satellite platform. "The convergence (of the NOAA and DMSP satellites) has been discussed since 1972. Currently the programs use the same spacecraft bus, launch facilities and extensively share data. DoD has held that convergence is technically feasible but policy issues preclude it. Policy issues include orbit selection flexibility, data downlink encryption and militarization of space." (AQS PEM) Given that convergence is technically feasible, and DoD budgets are rapidly declining, it is imperative that we move beyond the policy problems and seek means to accomplish this convergence as rapidly as possible.

Another area in which we are already planning a joint effort is multispectral imagery systems, i.e. Landsat. "After months of negotiations, the White House National Space Council and several federal agencies agreed last autumn to shift responsibility for the Landsat program from NOAA to NASA and the military. NASA would pay for Landsat operations and the Defense Department would foot the large bill -- more than \$250 million per spacecraft -- for construction of future satellites." (5:17) This proposal was presented to Congress, and in October 1992, "new legislation approved just before Congress adjourned gave NASA and the U.S. Defense Department the green light to take over the Landsat program." (6:4) By sharing the costs with NASA, the DoD, who is the largest user of Landsat data, (5:17) will be able to reduce

the total dollars spent from the Defense budget while still obtaining the capability it needs.

Navigation systems offer another opportunity to develop a joint program with another agency, in particular the Federal Aviation Administration. Currently, the FAA controls and funds all U.S. based navigation aids used for airline navigation. In the future, the airline industry and the FAA intend to rely more and more on satellite navigation systems for en-route navigation and approach. Aviation Week stated that "recent events indicate the U.S. Global Positioning System will become the primary navigation satellite system for civil aviation." (7:34) However, GPS is currently operated and fully funded by the DoD to support military missions. Given the tremendous potential use of the system by civil aviation, it appears reasonable to propose that the FAA assume a fair share of the funding burden for the system.

Joint efforts with other countries

Looking beyond U.S. government agencies for possible joint efforts, the other prime opportunity appears to be joint efforts with other Allied governments. The expansion of space technology almost drives us to this option. A regional type security agreement specifically for space assets may provide the best way to make use of the world wide assets that are coming on-line and reduce our costs at the same time. Regarding space capabilities, the Center for National Security Studies stated:

Now allies and would-be allies are demanding more, seeking know-how as well as access, and

so posing sharp issues for the United States...Despite strong counterpressures, it seems likely that the U.S. will need to find ways to cooperate more fully, and to share some capability as well as product, as the entire context of its earlier policy is transformed by realignments in international security relations, the evolution of data rich international regimes, and the globalization of defense and aerospace industries.(Spc book p13)

The U.S. and France have already taken a strong step in this direction when they announced in January 1993 that they had reached agreement on "future cooperation in space-based military programs." (SN 1/25) A U.S. Defense Department official stated that "We believe that cooperation with France offers the potential to reduce costs, promote interoperability, and assist in stemming the proliferation of missiles and military space systems, technologies and knowledge to adversaries." (SN 1/25) In particular, foreign imaging systems offer the potential for synergistic support for U.S. systems, allowing the DoD to reduce its systems and costs. Two systems already in the developmental process are the French military reconnaissance satellite, Helios, and the Canadian radar imaging satellite, Radarsat. Helios will be launched in the mid-1990s with optical capability. "Following this will be the orbiting of a pair of second-generation spacecraft equipped with visual and infrared instruments. A

third generation of Helios platforms will be launched in the next decade and will be equipped with radar." (8:63) The Canadian Radarsat is scheduled for launch in early 1995. "Radarsat is specifically designed to work in an operational mode" as compared to Japanese and European radar satellites, which are primarily experimental. (9:16) These systems offer an imaging capability that could be tied into DoD requirements and provide support to meet DoD needs, thereby reducing the necessary capabilities or number of systems that the DoD must field and also the cost.

Fee For Government Space Products

The second alternative for reducing costs, providing DoD satellite "products" to commercial users for a fee, offers the advantage of allowing DoD to remain in control of its systems while reducing the cost to operate those systems. Imagery systems are already moving in this direction. In the legislation approving the joint DoD/NASA venture for Landsat, Congress also stipulated that the "U.S. government should make imagery from Landsat 7 available to all users at the cost of reproducing it." (6:4) While this is a small step (the fees received will make little impact on reducing the total DoD cost of the program), it is a move in the right direction. Another action being considered is to provide existing DoD satellite imagery and weather data to scientists.

"U.S. government officials will examine exhaustively the U.S. Defense Department's trove

of spy-satellite data to identify information that would be useful to scientists, if Congress provides funds for the effort....Under the proposal, experts from the U.S. Defense Department and U.S. Energy Department would prepare an unclassified encyclopedic listing of the types of imagery in government archives...The imagery study would be part of a larger effort to widen access to a variety of remote-sensing data, such as weather readings, collected by the military. (10:10)

Under this concept, both imagery and weather products could be made available to commercial users, who would pay a fee for their use. Future upgrades to spacecraft and ground stations could also provide near real time data transmission to commercial users, at a correspondingly higher price. Given the success of France's SPOT imaging spacecraft in the commercial market, and SPOT's intent to be commercially self sustaining by the end of the century, selling imagery for fee could provide significant funds for the DoD.

Navigation, and in particular the GPS system, also provides an opportunity to collect a fee for the product provided. An alternative that could be implemented is to charge the commercial airlines, a key user of the system in the future, for use of the GPS system. By increasing the landing fees the FAA levies on the airlines by some percentage, significant funds could be collected

that could be placed in the FAA Trust Fund and earmarked specifically for operating and upgrading the GPS system.

Utilization of Commercial and Military Assets

The third alternative for reducing costs is to use a combination of commercial and military systems to meet military requirements. This is already evident in the communications arena. As we saw in Desert Shield/Storm, we underestimated our communications requirements and had to rely on commercial satellite communications for a significant portion of our capability. This option also reduces costs. In September 1992, Columbia Communications Corporation won a contract to "provide transmission links in the Pacific region for a major U.S. Defense Department communications network...The service will relay communications between seven U.S. military sites in Japan, Korea, Guam, Okinawa, Hawaii and the continental United States." (11:2) The contract offered a 30% savings over current transmission costs. (11:2) The Rand Corporation, in a 1992 study, concluded that "commercial communications satellite systems are likely to be used more and more frequently by the U.S. Army and the military in general. The escalating costs and longer product development cycles for the stringently specified military equipment often present a stark contrast to the technological dynamism, quick turnaround, and lower prices of the commercial marketplace." (Rand/Army) We in the DoD must take advantage of this commercial capability, sort out what requirements can be

adequately met by this capability, and press ahead to make use of it.

Imagery is another area that is already seeing the use of commercial assets to support military missions. France's Spot satellite, a commercial venture, provided important satellite imagery in support of Desert Storm. "The U.S. Air Force used France's Spot satellite imagery to rehearse key missions in the war against Iraq, and the data provided tactical air planning capabilities deemed valuable by the other military services."

(13:22) Brian Gordon, chairman of a multispectral requirements working group at the Defense Intelligence Agency, estimated that "the Defense Department purchased \$5-6 million worth of civil multispectral imaging data for Desert Storm." (13:22-23) Obviously, this cost is far less than developing, launching and operating our own multispectral system with Spot's resolution, and we simply obtained the data as we needed it, paying only for what we used.

Total Reliance on non-DoD Assets

The final alternative for reducing DoD costs is complete reliance on non-DoD and commercial systems to meet mission requirements. Obviously, this is a difficult task in most mission areas, since the DoD has warfighting requirements that simply don't exist on commercial satellites. However, some opportunities exist, and it is possible that some subsets of a particular mission area could totally rely on non-DoD or commercial assets to meet mission requirements.

Multispectral imagery (MSI) also offers the possibility that this subset of the imagery mission could be met by commercial assets. The Spot satellite has already shown that it can provide MSI products in a timely fashion to support military operations. Landsat could also be returned to a totally commercial enterprise. While many will say that the current commercial arrangement for selling data from existing on-orbit assets did not work, options exist. "A Congressional report released on July 22 (1992) by the Office of Technology Assessmentcalled the commercialization effort a partial success." (15:6) Others propose that the government "promise to buy enough remote-sensing data to justify privately funded satellite construction. NASA is testing that idea in SeaStar, an ocean study satellite that Orbital Sciences Corporation...agreed to build after the agency pledged to buy at least \$43 million worth of the satellite data." (15:6) These concepts could be applied to Landsat and the MSI mission area, with the potential of reducing costs and paying for only the products that the DoD needs.

Summary

Today's world environment of expanding space capability and converging technologies provides an opportunity for the DoD to move away from total reliance on dedicated space assets. Opportunities exist across a spectrum, from U.S. government joint programs to total reliance on commercial assets. In the post-Cold War environment of regional conflict, our space assets are under little risk of direct attack, and we must exploit this

reduced threat environment to seek greater reliance on allied and commercial space assets at reduced cost to the DoD.

CONCLUSION

As the DoD moves into the 1990s, the space arena is markedly different than that which we faced in the previous decades. A declining defense budget will force the DoD to examine new ways to accomplish its mission at reduced costs, and the explosion of non-DoD space assets provides an opportunity to capitalize on the availability of these assets. In addition, the much reduced threat to a direct attack on our space assets should allow us to utilize non-DoD assets to meet DoD requirements and the needs of the warfighter. Potentially reduced R&D investment by the DoD, as well as the rapid advancement of technology in the commercial space arena, also suggests a trend that DoD will no longer be the technology leader in many areas of space hardware development. The advances in commercial space communications capability already validate this point. Given the reduced threat, declining budgets, and increased capabilities outside the DoD, utilization of these "dual use" assets must be pursued to reduce the costs of developing, producing and operating DoD space systems.

Several avenues to pursue this goal exist. First, DoD must address its communication shortfall that was demonstrated in Desert Shield/Storm and seek long term arrangements for utilization of commercial space communications assets. On going MILSATCOM requirements studies must clearly identify those communications requirements that can be met by the very capable commercial assets now available and projected to be available in

the future. We must then take action to implement agreements to utilize those assets. Secondly regional agreements must be pursued to develop an allied space roadmap in which the current trend of the U.S., Europe and Japan to "go it alone" in military space capabilities is reversed. The recently approved agreement with France is a step in the right direction, but this agreement needs to be broadened to include more mission areas and other countries. Third, we must determine if other civil and commercial assets can support DoD requirements. Imagery and weather satellites offer potential benefits in this arena.

Clearly, we face tremendous challenges in the space arena as we seek to increase capabilities, support the warfighter, and live with a steeply declining budget. Old ways of doing business simply will not be acceptable; innovative approaches are called for that harness the world-wide spectrum of space assets to meet DoD requirements. Joint efforts, selling DoD products, and reliance on commercial capabilities all offer possibilities to meet the warfighters needs with the dollars we have. As Laurel Wilkening, chairman of the National Space Policy Assessment Task Group, stated, "We have to reconsider what has been the reality of our entire careers." (14:1) That is our challenge.